

NASA Earth Science Technology Program

January 26, 2010

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Background

Excerpt from an Interview with
Norm Augustine, Chairman, U.S. Human Space Flight Plans Committee
- *Space News*, August 24, 2009:

Q: Do you see a need to reform the way the U.S. Government conducts research and development?

A: “Developing components of systems during systems development or test is... very costly. Far better to develop components and, when they’ve been proven, go... put them into systems. That suggests the need for very strong technology programs... if you don’t do it, you end up having the component failures that stop you in the midst of system development where the money burn rate is very high”.

***ESD has been successfully using this approach
to technology development for more than 10 years***



Introduction

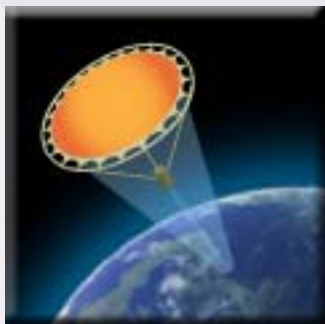
- The Earth Science Technology Office (ESTO) is a *science-driven, competed, actively managed and dynamically communicated technology program*
 - Competitive, peer-reviewed proposals enable selection of best-of-class technology investments
 - Risk is retired before major dollars are invested: a cost-effective approach to technology development and validation
- Since the Earth Science Decadal Survey was published in 2007, ESTO has focused its Instrument, Component and Information Technology solicitations on Decadal Survey measurements

This has resulted in the award of 57 technology projects representing an investment of over \$105M directly related to the Earth Science Decadal Survey.



ESTO Programs

Observation Technologies:



Instrument Incubator Program (IIP)

provides robust new instruments and measurement techniques

Advanced Component Technologies (ACT)

provides development of critical component and subsystem technologies for instruments and platforms.

Information Technologies:



Advanced Information Systems Technology (AIST)

provides innovative on-orbit and ground capabilities for communication, processing, and management of remotely sensed data and the efficient generation of data products and knowledge



Program Schedule / Budget

(\$M)

Q

ROSES Solicitations

	FY10				FY11				FY12				FY13				FY14				FY15			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
IIP Solicitation NRA Release																								
ACT Solicitation NRA Release																								
AIST Solicitation NRA Release																								
In-Guide Totals (\$M)																								
Total ESD Budget (\$M)																								
% of Total ESD Budget																								



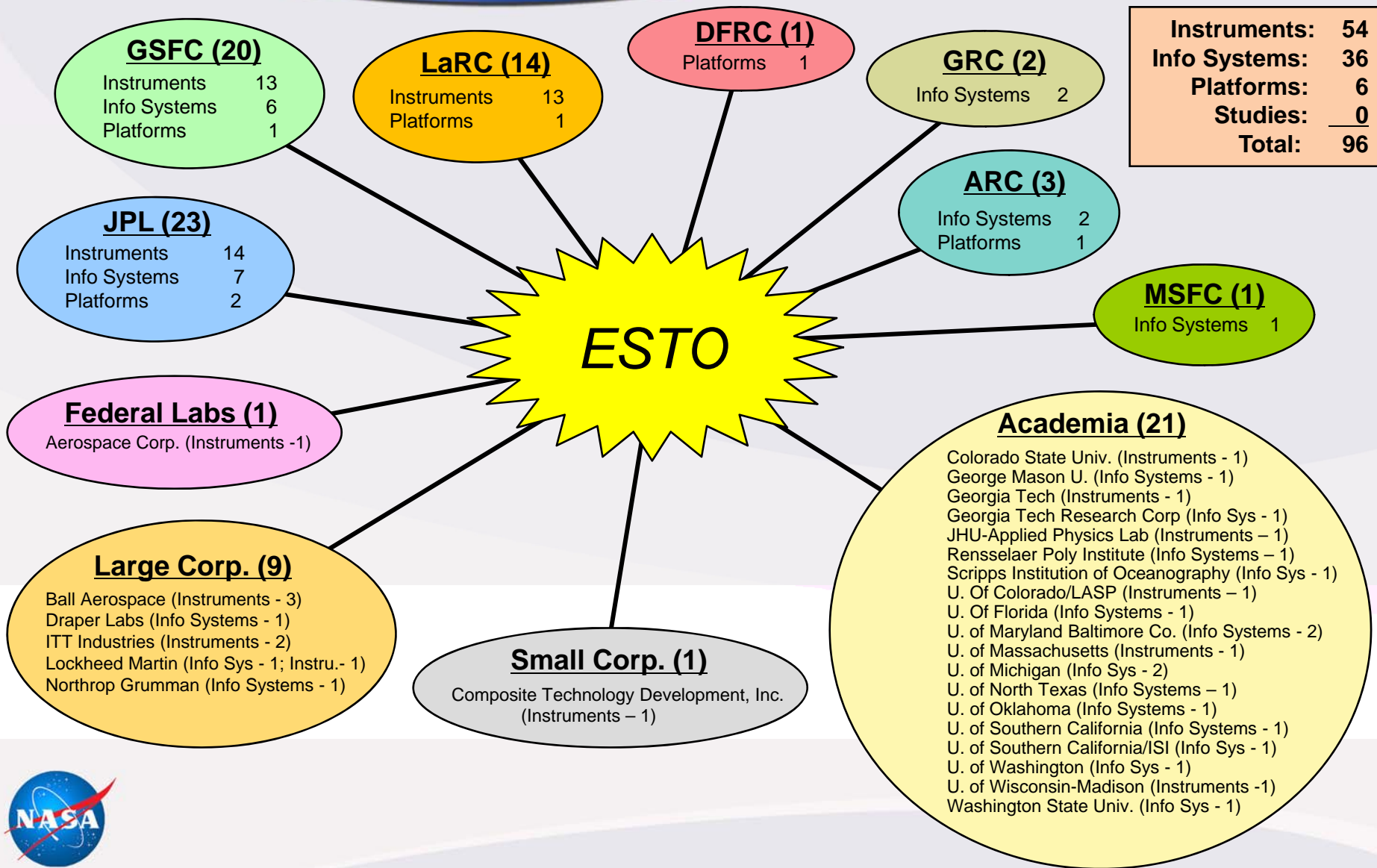
Progress to Date

Over the past eleven years, ESTO has issued fourteen competitive research solicitations, and funded and managed development on a wide range of technologies:

- 505 Projects Completed to Date (through FY09)
 - Principal Investigators from 102 different organizations located in 32 states and the District of Columbia:
 - 43 academic institutions
 - 43 companies
 - 11 national laboratories
 - 5 NASA centers
 - 365 projects (72%) advanced at least 1 technology level (TRL)
 - 172 projects (34%) already infused into missions/campaigns
 - 221 additional projects (44%) identified for infusion

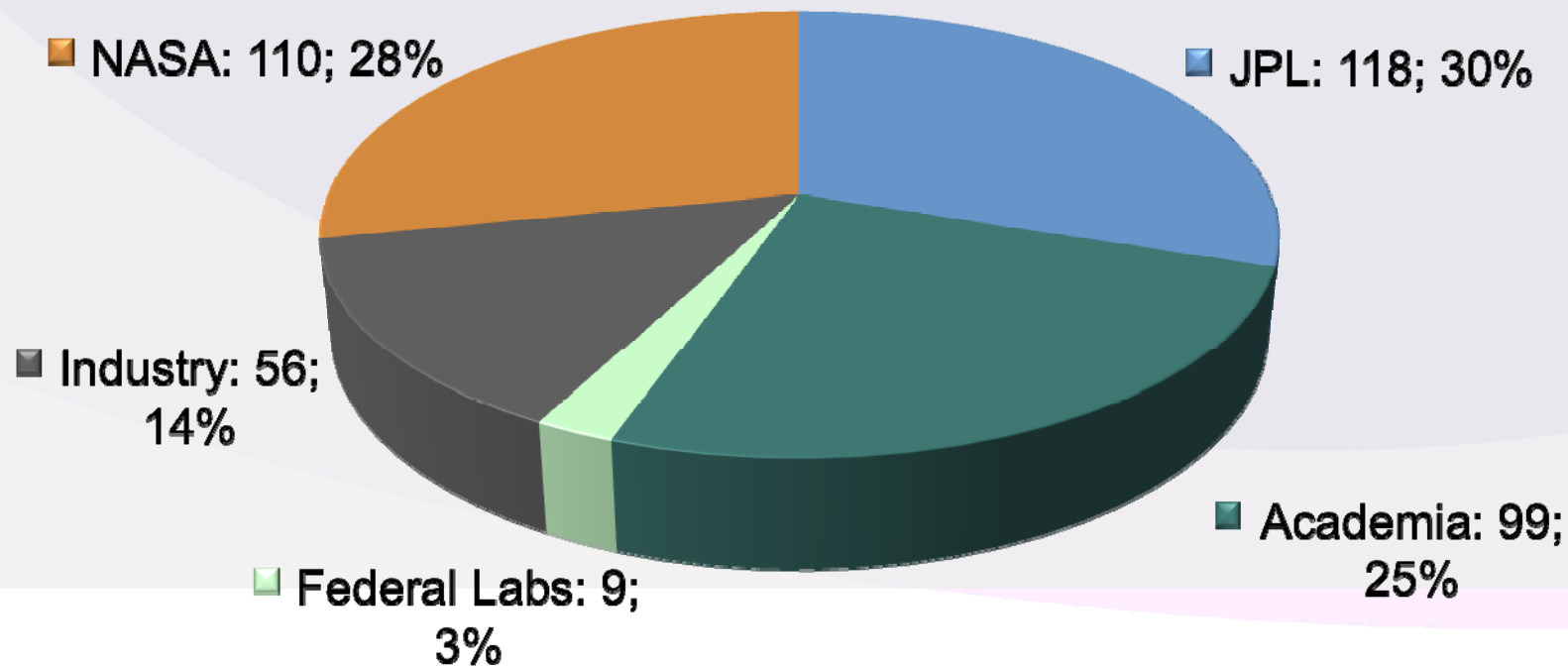


FY10 Technology Investments



ESTO Investigators

ESTO's 392 Active PIs and Co-Is Represent a Diverse Set of Institutions

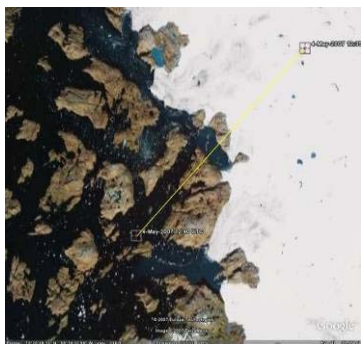


In 2009 alone, over 140 students from more than 39 institutions actively supported ESTO projects (138 ESTO projects were active during 2009). Approximately half are pursuing a Ph.D. Others are working toward masters or undergraduate degrees or are involved in a postdoctoral program.



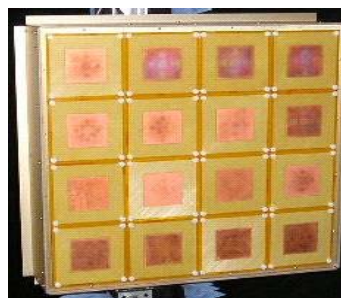
Highlights: Science Campaign Infusions

Greenland Campaign



Pathfinder Advanced Radar Ice Sounder (IIP-04: Raney)

CLASIC Campaign (Department of Energy)

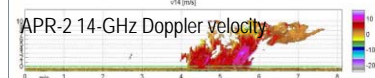
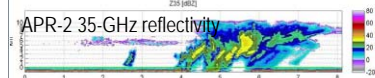
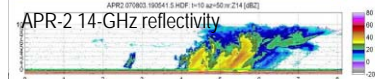
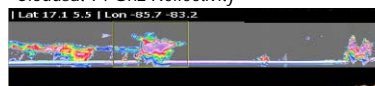


Lightweight Dual-Frequency Microstrip Antenna Feed for Future Soil Moisture and Sea Surface Salinity Missions (ACT-05: Yueh)

Tropical Composition, Cloud and Climate Coupling (TC4)



Cloudsat 94 GHz Reflectivity

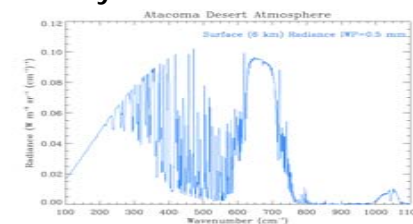


Advanced Precipitation Radar-2 (IIP-02: Im)

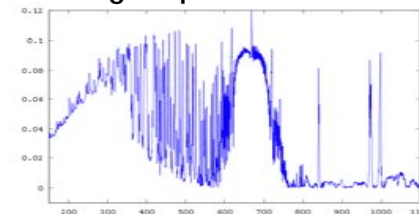
RHUBC-II Campaign (Cerro Toco Plateau, Chile)



Theory



First Light Spectrum - 8/21/09

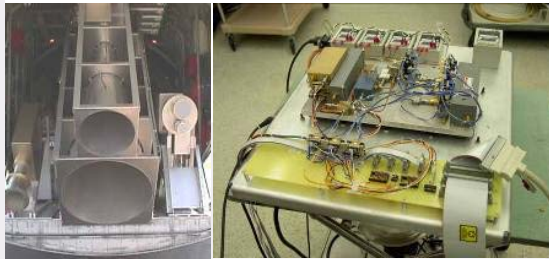


Far Infrared Spectroscopy of the Troposphere (FIRST) (IIP-04: Mlynczak)



Highlights: Mission Infusions

Ultra-Stable Radiometers
IIP-02: Bill Wilson



RFI Suppression System for
Microwave Radiometers
ACT-02 and ACT-05: Jeff
Piepmeier and Joe Knuble



Controlled-Correlation
Calibration Subsystem
ACT-99: Ed Kim & Jeff
Piepmeier

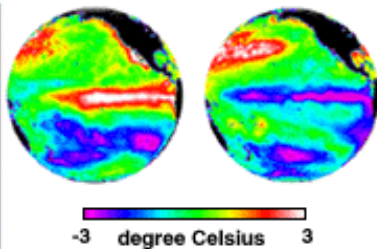


Aquarius ESSP

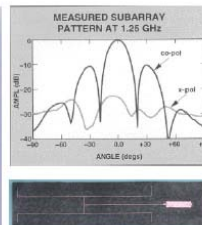
Launch: 2011



ParVox



Parallel Volume Rendering
CT-03: Peggy Li



Lightweight Feed For Future
Salinity Missions
ACT-02: Simon Yueh



Digital Detector for RFI
Detection (Ground Truth)
IIP-07: Christopher Ruf

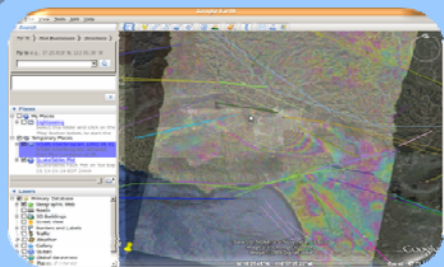


Highlights: Application Infusions



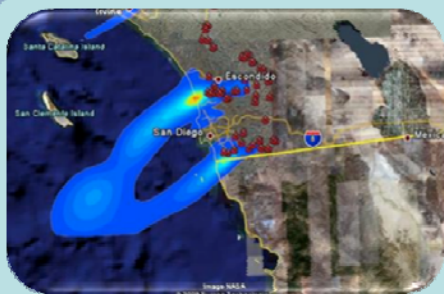
Disaster Response

The **Interoperable Sensor Architecture for Sensor Webs** project is working with over 40 partners world-wide to demonstrate automation and interoperability technologies for the rapid distribution of satellite data following various natural disasters. To date, the project has run numerous pilot projects that have substantively benefited society, including responses to several events in 2009 : the Station Fire in California, the Namibian floods (shown left), mudslides in Honduras and Guatemala, the Samoa Tsunami, and the Baja Mexico Hurricane. (AIST-05, Mandl)



Earthquake Forecasting

The **QuakeSim** project is advancing integration of both real-time and archival sensor data with computing applications to improve earthquake forecasts. The project has been in the news this year or work with the Los Angeles Department of Water and Power to analyze a rash of anomalous pipe breaks and any possible correlation to seismic activity. QuakeSim is also being applied to the DESDynI mission design and is being used for DAWN mission science analysis. (AIST-05 and AIST-08, Donnellan)



Air Quality Monitoring

The **Sensor-Analysis-Model Interoperability Technology Suite (SAMITS)** pilot project was used to analyze the impact of the 2008 California wild fires on air quality (visualization at left). The project, which fosters two-way data and control flow between active sensors and data analysis and modeling tools, has created collaborations to apply the technology to air quality forecasting and public health alert systems. SAMTIS is part of the GEOSS Air Quality and Health pilot program and is also being infused into the CEOS Atmospheric Composition Portal. (AIST-05, Falke)



Highlights: UAVSAR

Heritage



Status



Future



UAVSAR Capabilities:

- 2X better resolution than AIRSAR
- Agile waveform
- Multimode operation
- Over 1.2 million km² of L-Band Radar imagery
- Supporting DESDynI, SMAP and IPY
- Global Hawk UAV will carry two pods to enable increased range and Single Pass Interferometry

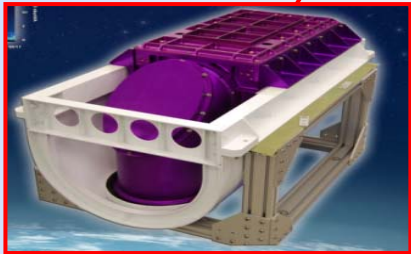
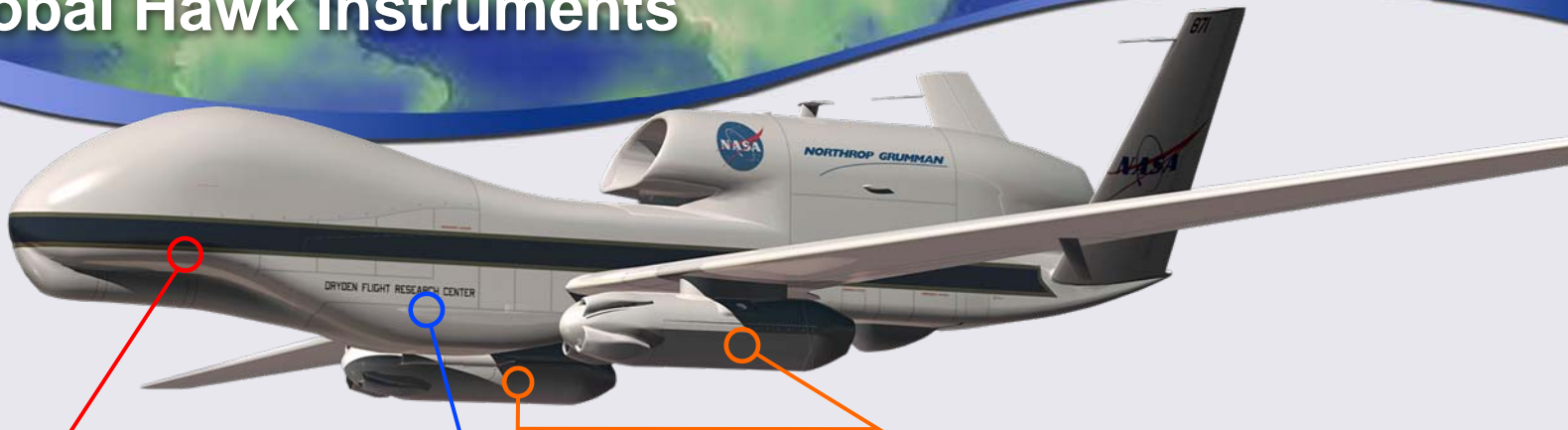
	First Flight	Mass	Power	Volume
AirSAR	1988	3840 lbs	> 10 KW	> 1500 cu ft
UAVSAR	2008	~1000 lbs	2.1 KW	81 cu ft



Today, UAVSAR is a fully capable airborne instrument for measurements of surface features – from glacier movement and seismic activity to vegetation change to land subsidence and groundwater use.

Stimulus-Funded Technology Development

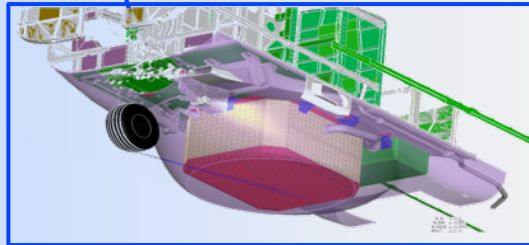
Global Hawk Instruments



Land, Vegetation, & Ice Sensor (LVIS)

This task will integrate the LVIS capability onto the Global Hawk and provide an automated, reliable package for high altitude measurements.

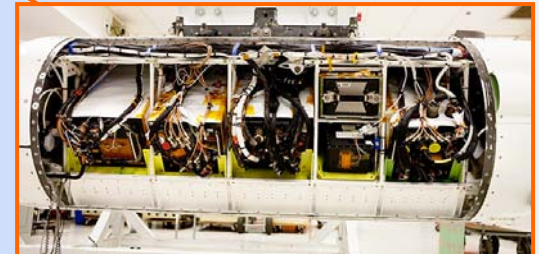
\$1.6M



Global Ozone Lidar Demonstrator (GOLD)

GOLD will enable, for the first time, Ozone LIDAR measurements from a high-altitude aircraft that support global atmospheric composition and climate change investigations.

\$1.5M



UAVSAR

The Uninhabited Aerial Vehicle – Synthetic Aperture Radar (UAVSAR) project will install two existing UAVSAR pods on a UAV for the first time. On Global Hawk, UAVSAR will generate precise topographic maps and single-pass polarimetric interferograms of ice and vegetation.

\$4.4M

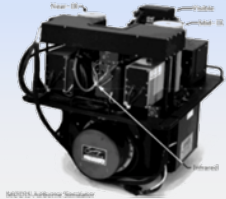


Stimulus-Funded Development: Facility Class Instruments

MODIS Airborne Simulator (MAS) Upgrades

This task will replace major subsystems on the MAS to extend its service life, increase reliability and improve data. The task will also increase spectral coverage, resolution, and calibration accuracy. The upgraded MAS will fly on the NASA ER-2.

\$3.0M



Portable Remote Imaging Spectrometer (PRISM)

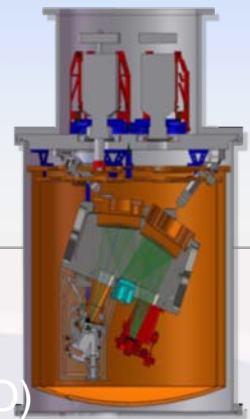
PRISM will be a UV-NIR (350 to 1050 nm) spectrometer capable of airborne measurements from a variety of platforms. PRISM will be particularly optimized for coastal ocean measurements, with unprecedented sensitivity across the large range of coastal reflectance. PRISM will be test flown on the NASA King Air.

\$5.0M

Next Generation Airborne Visible InfraRed Imaging Spectrometer (AVIRISng)

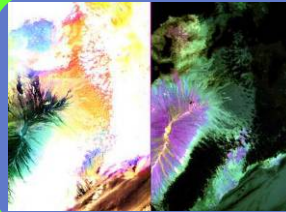
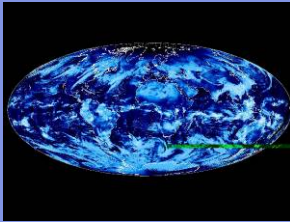
This next generation AVIRIS-class imaging spectrometer will help continue measurements of upwelling spectral radiance and support the HypSIRI Decadal Survey mission. Several new subsystems will help AVIRISng to achieve a factor of two improvement in SNR and spectral resolution relative to AVIRIS, as well as significant reductions in mass and volume for future flights on the DHC-6 Twin Otter.

\$1.5M



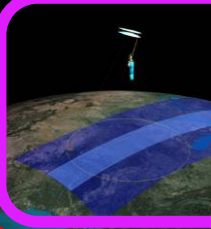
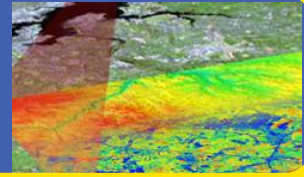
NASA Earth Science Decadal Survey Missions

Climate Absolute
Radiance and
Refractivity
Observatory
(**CLARREO**)



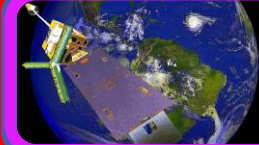
Hyperspectral
Infrared Imager
(**HYSPIRI**)

LIDAR Surface
Topography
(**LIST**)



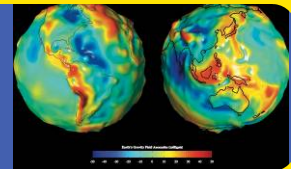
Soil Moisture Active
Passive (**SMAP**)

Active Sensing of
CO₂ Emissions
(**ASCENDS**)

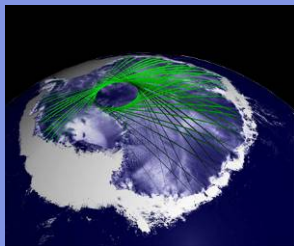


Precipitation and
All-Weather
Temperature and
Humidity (**PATH**)

Gravity Recovery
and Climate
Experiment - II
(**GRACE - II**)



Ice, Cloud, and
Land Elevation
Satellite II
(**ICESat-II**)



Surface Water
and Ocean
Topography
(**SWOT**)

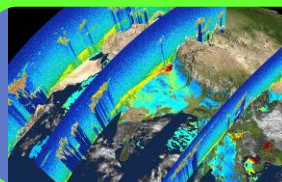


Snow and Cold
Land Processes
(**SCLP**)



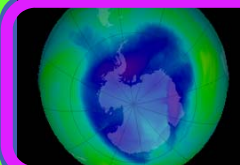
Deformation,
Ecosystem
Structure and
Dynamics of
Ice (**DESDynI**)

Geostationary
Coastal and Air
Pollution Events
(**GEO-CAPE**)



Aerosol - Cloud -
Ecosystems
(**ACE**)

Three-Dimensional
Winds from Space
Lidar (**3D-Winds**)



Global Atmospheric
Composition Mission
(**GACM**)


Lasers


Radars

Passive Optics


Passive Microwave


Current ESTO Investments: Enabling the Decadal Survey

 Instrument Technology Investments
(Instrument Incubator Program Solicitation)

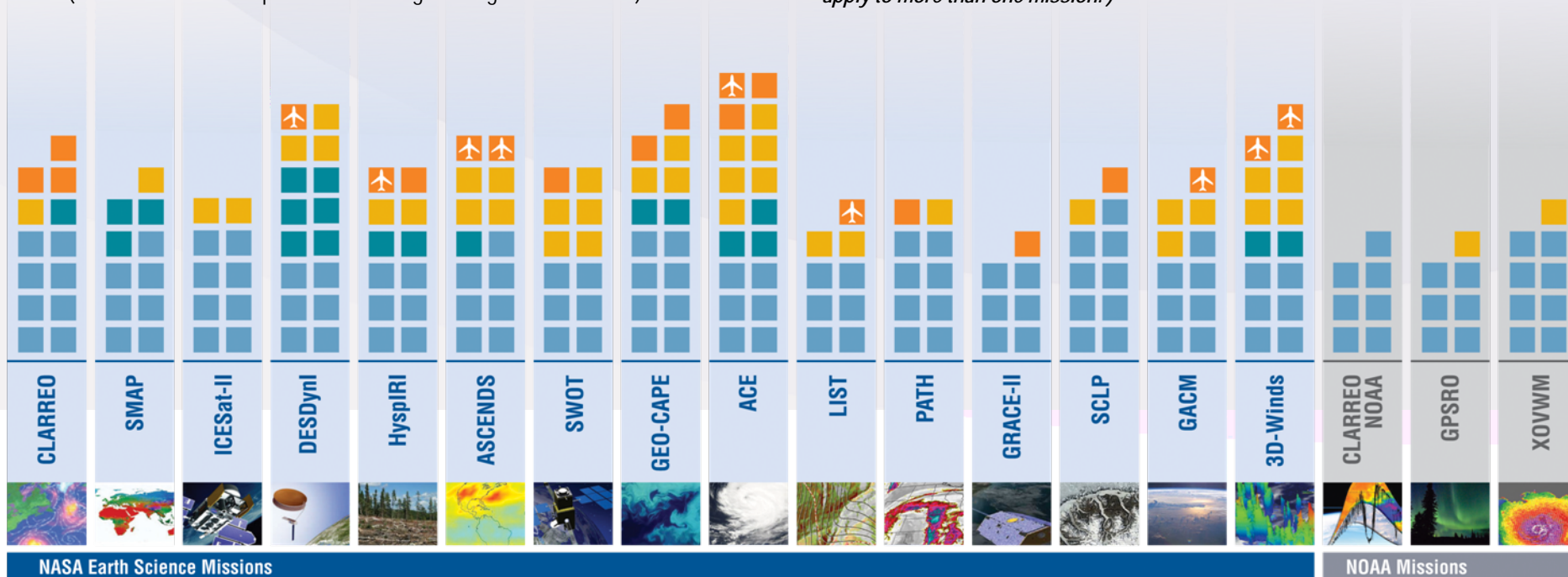
 Instrument Investments that include planned airborne testing
(2007 Instrument Incubator Program Solicitation)

 Component Technology Investments
(2008 Advanced Component Technologies Program Solicitation)

 Information Systems Technology Investments with Direct Applicability
(2008 Advanced Information System Technologies Program Solicitation)

 Information Systems Technology Investments with Secondary Applicability
(2008 Advanced Information System Technologies Program Solicitation)

(Note that individual Component and Information Systems Technologies often apply to more than one mission.)



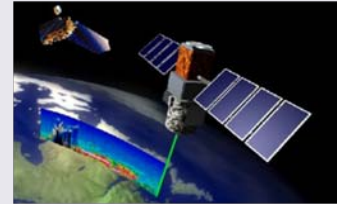
NASA Earth Science Missions

NOAA Missions

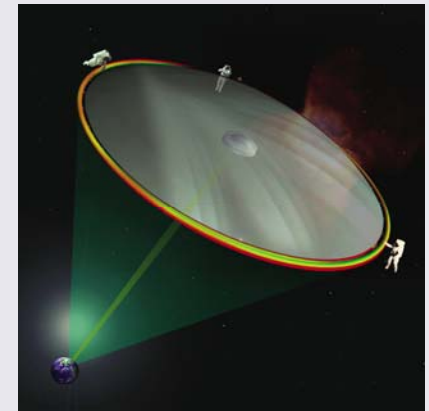


Earth Science Technology Challenges

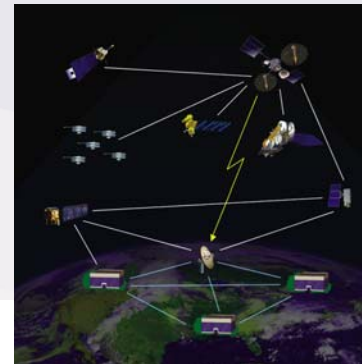
Active Remote Sensing Technologies to enable atmospheric, cryospheric and earth surface measurements



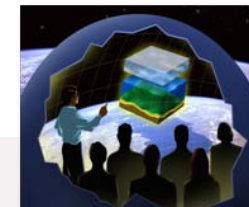
Large Deployables to enable future weather, climate and natural hazards measurements



Intelligent Distributed Systems using advanced communication, on-board reprogrammable processors, autonomous network control, data compression, high density storage



Information Knowledge Capture through 3-D visualization, holographic memory and seamlessly linked models.



Conclusions and Current Status

- A focused, science-driven approach
- Peer-reviewed process
- Open, competitive program
- Frequent solicitations ensure current approaches and create regular, multiple opportunities for PIs
- Technology options rather than point solutions
- Technologies selected for infusion by principal investigators and mission managers, not ESTO
- Currently funded technologies are providing state-of-the-art instruments, components, and information systems capabilities for a wide range of Earth science measurements.
- In 2007-2008, 57 new awards for instrument, component, and information system technologies were selected by NASA and awarded over \$105M in funding. These technologies are providing new capabilities that will enable the Earth Science Decadal Survey missions.





Technology Enables our Future



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